

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:)	Examiner: Marc A. Patterson
)	
Brian M. Sager et al.)	Art Unit: 1782
)	
Application Serial No. 10/698,988)	
)	
Filed: October 31, 2003)	Attorney's Docket No. NSL-014
)	
For: INORGANIC/ORGANIC HYBRID)	
NANOLAMINATE BARRIER FILM)	

ON APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES
APPELLANTS' REPLY BRIEF

MAIL STOP APPEAL BRIEF - PATENTS

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22304-1450

Dear Sir:

This Reply Brief filed in connection with the above captioned patent application, is responsive to the Examiner's Answer dated February 6, 2012. An Appeal Brief was previously filed by Appellant on October 28, 2011.

Appellants hereby appeal to the Board of Patent Appeals and Interferences from the final rejection in this case.

The following constitutes the Appellants' Reply Brief on Appeal.

I. REAL PARTY IN INTEREST

The real party in interest is Nanosolar, Inc., by an assignment of 100% of all interests in the present application by all inventors of the present application.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

III. STATUS OF CLAIMS

Claims 12-17,19-22,25,26 and 28-38 are in this application.

Claims 12-17,19-22,25,26 and 28-38 stand rejected and Appellants appeal the rejection of this claim.

IV. STATUS OF AMENDMENTS

A summary of the prosecution history for this case is as follows:

Previously, a Non-Final Office Action was mailed on September 8, 2005, and a Response to the Office Action was filed April 11, 2005. A Supplemental Response to the Office Action was filed April 27, 2005. This was followed by a Final Office Action mailed July 26, 2005 and a Response after Final Office Action was filed Sept 26, 2005. An Examiner Interview was conducted on September 21, 2005. A Response to the Final Office Action and A Request for Continued Examination was filed Oct. 26, 2005.

A Non-Final Office Action was mailed on November 18, 2005. An Examiner Interview was conducted on January 10, 2006. A Response to the Office Action was filed February 13, 2006. A Supplemental Response to the Office Action was filed April 27, 2006. An Examiner Interview was conducted on April 28, 2006. This was followed by a Final Office Action mailed May 2, 2006 and a Response after Final Office Action was filed June 27, 2006. An Advisory Action was mailed on July 17, 2006. An Examiner Interview was conducted on July 26, 2006. A Response to the Final Office Action and A Request for Continued Examination was filed July 26, 2006.

A Non-Final Office Action was mailed on August 9, 2006, and a Response to the Office Action was filed December 1, 2006. A Final Office Action was mailed on February 23, 2007,

and a Response to the Final Office Action and A Request for Continued Examination was filed June 25, 2007.

A Non-Final Office Action was mailed on August 22, 2007. An Examiner Interview was conducted on October 5, 2007. A Response to the Office Action was filed February 22, 2008. A Final Office Action was mailed on May 14, 2008. An Examiner Interview was conducted on July 22, 2008. A Response to the Final Office Action was filed September 15, 2008. An Advisory Action was mailed on Sept. 30, 2008. A Notice of Appeal was filed on November 14, 2008 in this case. A Response to the Final Office Action and A Request for Continued Examination was filed Feb. 17, 2009. An Examiner Interview was conducted on Feb. 20, 2009.

A Non-Final Office Action was mailed on April 30, 2009 and A Response to the Office Action was filed October 30, 2009. A Non-Final Office Action was mailed January 25, 2010 and A Response to the Office Action was filed July 26, 2010. A Response to the Final Office Action was filed October 26, 2010.

A Notice of Appeal was filed on March 28, 2011 in this case.

A copy of the claims in the present Appeal is provided in the Claims Appendix.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Device with a barrier film is provided. Claim 12 provides a device comprising: a solar cell (page 7, line 14) encapsulated with a self-assembled barrier film structure thereon comprised of: a plurality of layers of an inorganic material (page 3, lines 1-11); and a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material (page 3, lines 1-11) and wherein more than one of layers of the organic polymer contain a superhydrophobic material (page 3, lines 15-20); wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded (page 7, line 4) layers characterized by direct organic polymer to inorganic material covalent bonds which form in the self-assembled barrier film structure even with superhydrophobic material in more than one of the layers of the organic polymer; wherein random location of pinholes in the layers of the inorganic material and the layers of the organic polymer requires a tortuous pathway marked by repeated turns or bends for any water to pass through the self-assembled barrier film structure (page 3, lines 23-30), wherein the superhydrophobic material in more than

one of the layers of the organic polymer provide surfaces that impede that movement of water between adjacent layers of the organic polymer and the inorganic material.

Claim 36 recites an inorganic/organic nanolaminate barrier film, comprising: a self-assembled structure comprised of: a plurality of layers of an inorganic material (page 3, lines 1-11); and a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material (page 3, lines 1-11) and wherein more than one of layers of the organic polymer contain a superhydrophobic material (page 3, lines 15-20); wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded layers characterized by direct organic polymer-inorganic material covalent bonds (page 7, line 4) between adjacent layers which form in the self-assembled structure even with the superhydrophobic material in the one or more layers of the organic polymer; wherein the layers of the organic polymer contain superhydrophobic material (page 3, lines 15-20)l.

Claim 37 provides a device comprising: a photovoltaic device (page 7, line 14) with an inorganic/organic nanolaminate barrier film formed thereon, wherein the self-assembled barrier film comprises: a plurality of layers of an inorganic material (page 3, lines 1-11); and a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material (page 3, lines 1-11) and wherein more than one of the layers of the organic polymer contain a superhydrophobic material (page 3, lines 15-20); wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded layers (page 7, line 4) characterized by direct organic polymer-inorganic material covalent bonds (page 7, line 4) between adjacent layers which form in the self-assembled barrier film even with the superhydrophobic material in the one or more layers of the organic polymer; wherein the layers of the organic polymer contain superhydrophobic material; wherein a bottom layer of the barrier film in contact with the photovoltaic device is an inorganic layer; wherein random location of pinholes in the layers of the inorganic material and the layers of the organic polymer requires a tortuous pathway marked by repeated turns or bends for any water to pass through the self-assembled barrier film structure (page 3, lines 23-30), wherein the superhydrophobic material in more than one of the layers of the organic polymer provide

surfaces that impede that movement of water between adjacent layers of the organic polymer and the inorganic material

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether Claims 12 - 17, 19 - 22,25 - 26,28 - 35 and 37 - 38 are rejected under 35 U.S.C. 112, first paragraph.

2, Whether Claims 12 - 17, 19 - 26 and 28 - 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brinker et al (U.S. Patent No. 6,264,741 B1) in view of Dams (European Patent No. 1225188) and Burrows et al (U.S. Patent No. 6,866,901 B2) and Fujimori et al (U.S. Patent No. 6,727,513 B2).

VII. ARGUMENTS

Summary of the Arguments:

The summaries of arguments are all discussed in greater detail, under their appropriate headings.

- a) The proposed claim language is fully supported by the specification.
- b) The Office has failed to show that Brinker in view of Dams, Burrows, and Fujimori shows all elements of the claimed invention.
- c) The Office has not established the propriety of the combination of Brinker in view of Dams, Burrows, and Fujimori.

Response to Rejections

ISSUE 1. Rejection under 35 U.S.C. 112, first paragraph

(This rejection has been withdrawn by the Office in the Examiner's Answer.)

ISSUE 2. Rejection under 35 U.S.C. 103(a) of Brinker in view of Dams, Burrows, and Fujimori

Independent Claims 12 and 37 recite claim elements not shown or suggested by the citations

Claims 12-17, 19-26, and 28-38 were rejected under 35 USC 103(a) as being obvious over Brinker et al. (U.S. Patent 6,264,741) to in view of Dams (European Patent No. 1225188) and Burrows (U.S. Patent 6,866,901) and Fujimori (U.S. Patent 6,727,513). Appellants traverse this rejection.

As an initial matter, claim 12 recites that superhydrophobic material is in more than one of the layers of the organic polymer in the self-assembled structure.

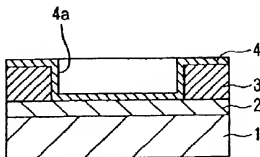
The Office acknowledges in the Final Office Action of Oc. 16, 2010 on page 5, lines 5-7 that Brinker, Dams, and Burrows does not establish that it is physically possible to form a self-assembled film using a superhydrophobic monomer. To rectify this deficiency, the Office has cited the Fujimori reference as teaching a self-assembled film (col. 3, line 26). However, closer reading shows that Fujimori (col 3, line 26) states that the self-assembled film is a self-assembled single layer, not a multilayer stack of 100s to 1000s of layers as presently taught and not establish that there is superhydrophobic material in more than one of the layers of the organic polymer in the self-assembled structure. Specifically, Fujimori states:

The term "self-assembled film" as used in the present invention means a monomolecular film which is obtained by allowing a compound having a straight-chain molecule and a functional group that can be combined with the constitutive atom of a face on which the film is formed and is bonded to the straight-chain molecule to become in the state of a gas or liquid and coexistent with the face on which the film is formed. In the monomolecular film, the functional group is adsorbed by the film-forming face and is bonded with the constitutive atom of the film-forming face, and the straight-chain molecule is formed facing the outside. This monomolecular film is referred to as a self-assembled film, since it is formed by spontaneous chemical adsorption of the compound to the film-forming face. (Fujimori: col 3, lines 26-39)

Thus, all of the teachings in Fujimori provide no additional teaching or suggestion as to the self-assembly of a multi-layer nanolaminate having more than one layer with a superhydrophic material. As seen in the above text, Fujimori teaches only the formation of a

single self-assembled monomolecular film, not a self-assembled multi-layer nanolaminate.

Figure 4(a) in Fujimori (shown below) emphasizes that the self-assembled film 4 of Fujimori is but a single layer, not a self-assembled multi-layer nanolaminate.



[FIG. 4]

Fujimori does not establish teachings beyond a monomolecular film. Whatever teaching may be provided by Fujimori, they are not relevant to a self-assembly multi-layer nanolaminate wherein more than one layer has the superhydrophobic material.

Claim 12 clearly recites Furthermore the single layer described in Fujimori cannot serve as the substrate for which a tortuous path exist, because by definition, a tortuous path requires interconnection of randomly sited pinholes from multiple adjacent layers.

In the Examiner's Answer on the bottom of page 6 and top of Page 7, the Examiner has conceded that "Brinker et al, Dams and Burrows et al do not establish that it is physically possible to form a self- assembled film using a superhydrophobic monomer". The Examiner states that "Fujimori et al teach a self assembled film (column 3, line 26) comprising fluoroalkylsilane (column 3, lines 45 - 49). Fujimori et al therefore establishes that it is known in the art that it is physically possible." This, however, is in clear error as established in the preceding paragraphs, Fujimori does not provide any teaching with regards to how self-assembly will be impacted by fluoroalkylsilane since Fujimori only provides a top-coat of the

material, not a self-assembly of many layers of alternating organic-inorganic material as taught in Appellants presently claimed embodiment.

The Proposed Combination between Brinker and Fujimori is Incompatible

Furthermore, Brinker has already discarded the Langmuir-Blodgett monolayer self-assembly of Fujimori (see Fujimori: col 3, lines 36-43) as being incompatible to forming the proposed nanocomposite described in Brinker.

In an attempt to mimic these examples from nature, a synthetic process termed "biomimetics" has gained momentum within the scientific community. Such approaches include crystallization beneath Langmuir monolayers, crystallization on self-assembled monolayers, supramolecular self-assembly (SSA), and sequential deposition (SD). Of these only SSA and SD offer the ability to introduce the periodic microstructural and compositional changes necessary for layered nanocomposite formation. (Brinker, Col. 1, lines 36-44).

Accordingly, one of ordinary skill in the art would understand that these existing techniques were unsuitable for the proposed concept of forming layer nanolaminate formation desired by Brinker.

There is no teaching in Fujimori with regards to a self-assembled multi-layer nanolaminate that rectifies the deficiencies of Brinker, Dams, and Burrows. Fujimori's teaching regarding single layer self assembly would not be of use in Brinker's nanolaminate technique and one of skill in the art, as stated by Brinker, understand that those techniques such as that of Fujimori do not offer the ability to introduce the periodic microstructural and compositional changes necessary for layered nanocomposite formation.

No where does Fujimori speak to this or rectify the deficiencies of Brinker, Dams, and Burrows with regards to self-assembly of a multi-layer nanolaminate with superhydrophobic material in more than of the organic polymer layers. Self-assembly of a single layer is insufficient; self-assembled multilayer is required in the claimed invention. Furthermore, even if a single layer can be self-assembled, that alone provides no teaching on how to establish the self-assembly of many multiple layers having the superhydrophobic material.

Rejection is devoid of an articulation of some reason to combine.

A prima facie case of obviousness requires a rationale to combine. The Office admits on page 4 of the Final Office Action that Brinker et al fail to disclose layers that contain superhydrophobic material and comprise fluoroalkylsilane and a solar cell encapsulated with the film. The Office finds other references to try to rectify these deficiencies, but there is no rationale to combine.

The Office states that one would recognize that the advantage of providing for the monomer of Dams et al in Brinker et al. The Office states that Dams teaches a monomer comprising fluoroalkylsilane (paragraph 0008), therefore superhydrophobic. There is, however, no rationale to combine Dams with Brinker as previously cited, other than the rationale cited by the Appellant, as the use of superhydrophobic material will likely interfere with the self-assembly of Brinker (which requires a balance of hydrophobic and hydrophilic forces for self assembly, see Chandler affidavit of June 11 2009). There is no rationale to add this superhydrophobic material into the self-assembly process, other than the motivation suggested by Appellants. The advantage provided by Dams would not manifest in Brinker as the superhydrophobic material of Dams would likely interfere with self assembly of Brinker.

The Office states that Fujimori et al teaches a self-assembled film (column 3, line 26) comprising fluoroalkylsilane (column 3, lines 45 - 49). Fujimori et al therefore establishes that it is known in the art that it is physically possible. Again, however, no rationale to combine is stated. Brinker has already discarded the Langmuir-Blodgett monolayer self-assembly of Fujimori (see Fujimori: col 3, lines 36-43) as being incompatible to forming the proposed nanocomposite described in Brinker. Thus, there is no rationale to combine these two incompatible references. The advantage provided by Fujimori would not manifest in Brinker as their processes do not appear compatible.

Surprising Result

The previously submitted Chandler affidavit of June 11, 2009 shows that it was a surprising result that a multilayer nanolaminate as claimed could be formed and nothing in Fujimori teaches anything regarding forming multi-layer nanolaminate as presently claimed.

Reasonable Expectation of Success Is Required

The Office has not set forth that there is any expectation of success. Obviousness does not require absolute predictability, however, at least some degree of predictability is required. Evidence showing there was no reasonable expectation of success may support a conclusion of nonobviousness. *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976)

The previously submitted Chandler affidavit of June 11, 2009 states that success in altering the Brinker self-assembly process is not straight forward or predictable. The Office has not met its burden in establishing that the proposed combination has a likelihood of success at the time the present invention was made. Whether an art is predictable or whether the proposed modification or combination of the prior art has a reasonable expectation of success is determined at the time the invention was made. *Ex parte Erlich*, 3 USPQ2d 1011 (Bd. Pat. App. & Inter. 1986)

Even if combined, Features in Claim 12 are not shown by the proposed combination

Appellants further emphasize structural elements in independent claim 12 not shown by the citations from the Office, even if all were combined as suggested by the Office. By way nonlimiting example, claim 12 recites that:

adjacent layers of the organic polymer and the inorganic material are covalently bonded layers characterized by direct organic polymer to inorganic material covalent bonds which form in the self-assembled structure even with superhydrophobic material in more than one of the layers of the organic polymer;

Thus, the self-assembly of many of these layers at the same time creates covalent bonding between adjacent layers of the self-assembled multilayer nanolaminate. There is no teaching that that bonding is created by forming single monolayers of material in a non-self-assembled manner, or that such bonds can be formed between layers if the single self-assembly layer of Fujimori is introduced together with the teachings of the other references.

The layers of organic polymer AND the layers of inorganic material are both formed as part of the self-assembly. In many of the citations, there is no teaching both of the layer types of formed through self-assembly.

Furthermore, the majority of the citations discussion formation of layers as individual steps, not through self-assembly of multiple layers. For example, the deposition of the barrier layers and the decoupling layers in Burrows appear as separate steps, none of which are shown to be self-assembly methods that form the claimed covalent bonds between adjacent layers. For example, Burrows recites formation of the layers using a plurality of sequential steps (depositing, etching, depositing, etc...):

Alternatively, depositing the at least one barrier stack adjacent to the substrate may include, but is not limited to, depositing the first decoupling layer having an initial area of decoupling material which is greater than the area of the first decoupling layer, etching the first decoupling layer having the initial area of decoupling material to remove a portion of the decoupling material so that the first decoupling layer has the area of the first decoupling layer, and depositing the first barrier layer. Etching the first decoupling layer may include, but is not limited to, providing a solid mask over the first decoupling layer having the initial area of decoupling material, and etching the first decoupling layer having the initial area of decoupling material to remove the portion of the decoupling material outside the solid mask so that the first decoupling layer has the area of the first decoupling layer. (Burrows, col. 3, lines 10-27).

As such, the citations fail to show or suggest the covalent bonding between adjacent layers that forms by way of self-assembly recited in the claimed invention.

Furthermore, even if Brinker were combined with Dams, Burrows, and Fujimori, the resulting device would not be the invention as set forth herein.

The teachings of Dams merely suggests a surface application of its fluorochemical silane (see page 3, lines 20-25). Dams describes applying the material to substrates or applied to hard surfaces. Combining Brinker with Dams merely results in a top layer with Dams' fluorochemical silane, not incorporation of superhydrophobic material into the nanolaminate as presently claimed. Nothing in Burrows provides an enabling disclosure as to how one can incorporate a superhydrophobic material into the self-assembled structure of Brinker. Fujimori only teaches formation of single monolayers, which is not enabling as to how to incorporate the superhydrophobic material into the Brinker multi-layers. As the cited references fail to show or suggest all elements of the claimed invention, Appellant respectfully requests that the rejection to claim 12 be withdrawn.

The Proposed Combination is Prohibited

Furthermore, the propriety of combining the teachings of Brinker, Dams, Burrows, and Fujimori has not been established. Specifically, MPEP 2143.01 prohibits the combination of references where the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified.

- a) Brinker discloses a self-assembly process.
- b) Dams describes various non-self-assembly coating techniques for depositing the superhydrophobic material (see below).

A wide variety of coating methods can be used to apply a composition of the present invention, such as brushing, spraying, dipping, rolling, spreading, and the like. A preferred coating method for application of a fluorochemical silane of the present invention includes spray application. (Dams, pg 22, lines 12-16).

- c) Burrows describes many deposition techniques, none described as self-assembly.

The barrier layers may be deposited by any suitable process including, but not limited to, conventional vacuum processes such as sputtering, evaporation, sublimation, chemical vapor deposition (CVD), plasma enhanced chemical vapor deposition

(PECVD), electron cyclotron resonance-plasma enhanced vapor deposition (ECR-PECVD), and combinations thereof. (Burrows, col. 7, lines 1-7)

d) Fujimori: describes self-assembly as chemical adsorption to form a single monolayer.

This monomolecular film is referred to as a self-assembled film, since it is formed by spontaneous chemical adsorption of the compound to the film-forming face.

In this connection, the self-assembled film is described in detail by A. Ulman in Chapter 3 of "An Introduction to Ultrathin Organic Film From Langmuir-Blodgett to Self-assembly" (Academic Press Inc., Boston, 1991). (Fujimori: col 3, lines 36-43)

It is entirely unclear how the teachings of the above references can be combined without significantly altering the fundamentals of the Brinker self-assembly process. As previously mentioned, Brinker has already discarded the Langmuir-Blodgett monolayer self-assembly as being incompatible with self assembly necessary layered nanocomposite formation.

Such approaches include crystallization beneath Langmuir monolayers, crystallization on self-assembled monolayers, supramolecular self-assembly (SSA), and sequential deposition (SD). Of these only SSA and SD offer the ability to introduce the periodic microstructural and compositional changes necessary for layered nanocomposite formation. (Brinker, Col. 1, lines 36-44).

Thus, based on the foregoing, the teachings of Fujimori has been established by Brinker as inappropriate for Brinker's technique, without significant fundamental changes.

Appellants are proceeding contrary to accepted wisdom

Per MPEP 2145(X)(D)(3), proceeding contrary to accepted wisdom is evidence of nonobviousness. Appellant submits that the material with Brinker seeks to mimic which hydrates like nacre would make for a poor moisture barrier and using that material as the basis for a moisture barrier is proceeding contrary to accepted wisdom. Specifically, Brinker seeks to mimic nacre (see Brinker Col. 1, lines 35-50), but nacre is not a water barrier. Nacre is easily hydrated after only five hours of soaking in water (see, e.g., Barthelat, "Tensile Testing of

Abalone Nacre Miniature Specimens Using Microscopy and Speckle Correlation”, page 2, col. 4, paragraph 2), and the toughness of the material is related to the degree of hydration (see, e.g., Menig et al., Quasi-static and Dynamic Mechanical Response of *Haliotis Rufescens* (Abalone Shells), Acta Mater. 48 (2000), page 2392, col. 1). Absent the teachings found in Appellant’s patent application, there is no motivation for one of skill in art to modify the nacre-like material of Brinker to be a moisture barrier. Appellant has proceeded against accepted wisdom by incorporating water barrier qualities into the presently claimed laminate and by starting with a poor moisture barrier material.

Based on the foregoing, Claim 12 and its dependent claims are allowable over the citations.

Claim 37 is allowable for substantially the same reasons set forth for claim 12. Claim 37 also recite a photovoltaic device wherein a bottom layer of the barrier film in contact with the photovoltaic device is an inorganic layer. Such a configuration is shown in Figure 1 and is beneficial as it prevents undesired interaction between the photovoltaic device and any organic material which may cause degradation in the cell.

Accordingly, Claims 12, 37, and their dependent claims are allowable over the citations and Appellants respectfully request that the current rejections be withdrawn.

Claim 36 is also allowable for substantially the same reasons set forth for claim 12.

Appellants Response to Examiner’s Comments to Final Office Action

On page 6 of the Final Office Action of October 26, 2010, the Office set forth responses to Appellant’s previous arguments. For example, the Office states “because Brinker et al do not limit the hydrophobic material that is used as the disclosed organic material, and Fujimori et al teach the formation of a self - assembled film using a hydrophobic material, it would be obvious to use the hydrophobic material of Fujimori et al in Brinker et al.” Appellants respond that it has not been established by the Office that there is any reasonable chance of success

Appellants Response to Examiner's Answer of February 6, 2012

The Examiner stated in the Examiner's Answer on Page 8:

Brinker et al do not exclude fluoroalkylsilane, or indicate that fluoroalkylsilane would interfere with self - assembly.

The fact that self - assembly occurs in the claimed invention also indicates that fluoroalkylsilane does not interfere with self - assembly.

Furthermore, as stated on page 5 of the previous Action, Fujimori discloses a layer of fluoroalkylsilane that is self - assembled.

Taking each of these points separately,

1)) it has been established that self-assembly would be challenged by a superhydrophobic material.. For example, in the Abstract of Brinker it is stated that **"Importantly, in the reaction mixture, the amphiphilic surfactant has an initial concentration below the critical micelle concentration to allow formation of the liquid-phase micellar mesophase material."**

Additionally, Per Examiner's request, Appellant in the response of September 15, 2008, provided a published technical paper setting forth the **delicate balance associated with a micelle-based, self-assembly process**. The paper entitled "Micelle Formation and Hydrophobic Effect" published in J. Phys. Chem. B 2004, 108, 6778-6781 succinctly describes the aforementioned balance in Equation 8 on page 6779 Col. 2. The ratio of hydrophobic to hydrophilic moieties is relevant, as is the average length between them. As discussed in 6779 Col. 2. in the text leading up to equation 8, there is a **hydrophobic** driving force identified in the Lum-Chandler-Weeks theory. As noted in the paper, the strength of the driving force would grow without bound leading to macroscopic clusters unless such contributions are countered. As discussed, the hydrophobic driving force is countered by the third term discussed the paper regarding placing **hydrophilic** headgroups on the micelle surface.

As the Examiner can appreciate from the cited paper, there are a number of variables in play during such formation including but not limited to the balance of hydrophobic and

hydrophilic moieties. Thus, to have a self-assembled structure formed using a superhydrophobic material as presently claimed is non-obvious.

Furthermore, per the Examiner's request, experiments conducted as part of Applicant's investigation show that using the techniques set forth in the present application, a seven (7) fold decrease in permeability relative to baseline perm abilities can be achieved. In such embodiments, the sol was made per the teachings of the present application by mixing silica precursor, ethanol, acid catalyst, and surfactant, then spin coating the sol at 1000 RPM onto the substrate, followed by either of two heating routes: (1) heat overnight at 100C under vacuum, or (2) condense silica under ammonia saturated atmosphere for 30 minutes, then heat two hours at 50C under vacuum. Both routes yielded substantially similar results. Structured or non-structured (negative control) films formed by the above process were double-coated onto commercially available membranes comprised of alumina (aluminum oxide) with 20 nm pores. Alumina is transparent in the visible spectrum, and easily spin coated. Templated films (using either cetyltrimethylammonium bromide (CTAB) (enabling 2nm pattern size) or and Plurionics 123 (P123) (enabling 8nm pattern size) as the surfactant resulted in nanolamellar films, and the permeation rate decreased a permeation decrease of about seven-fold for both cases.

In light of the supplied affidavit under under 37 CFR 1.132, altering the organic layer of the nanolaminate as claimed is non-obvious. As pointed out by the Office (Office Action of August 9, 2006 on page 5 lines 5-16), the traditional technique in the art as noted in the previously cited Singh reference is to change the inorganic layer by increasing the amount of silicate in the inorganic material to achieve good barrier properties (see Singh, page 64, lines 25-29). There is no teaching cited by the Office suggesting the modification of the organic layer to improve the moisture barrier qualities. Other than the teachings of the present application, Applicant fails to see where the Office has cited a rationale for the present combination of reference.

2) The Examiner is clearly relying on hindsight on page 8 of the Examiner's answer with the statement that "fact that self - assembly occurs in the claimed invention also indicates that fluoroalkylsilane does not interfere with self - assembly." The Examiner is using Appellant's own work in a hindsight manner to support Examiner's argument and this is clearly

prohibited. Prior to Appellant's own work, there is no rationale to combine, the Affidavits establish that one of skill in the art would have felt that this is proceeding against accept wisdom, and the Examiner has not shown (except through use of Appellant's own work) that there was any expectation of success prior to Appellant's own work.

3) As admitted by the Examiner's own statement, Fujimori discloses a layer of fluoroalkylsilane. Thus, Fujimori discusses only a single layer. The Examiner does not establish any connection to how this relates to a highly ordered self-assembly structure of alternating organic/inorganic layers.

On Page 8 of the Examiner's answer, the Examiner further states that:

However, the disclosure in Fujimori of fluoroalkylsilane that is self-assembled contradicts the statement in the Chandler affidavit that fluoroalkylsilane units attract one another too strongly for self-assembly to occur; it is also noted that the face on which the self-assembled film of Fujimori is formed is hydrophilic (column 3, lines 45 - 49 of Fujimori).

Here again, the Examiner is presenting argument related to only a single layer. The Chandler affidavit is in relation a highly ordered self-assembly structure of many alternating organic/inorganic layers. The Examiner's discussion of Fujimori is limited to a single layer of fluoroalkylsilane. Fujimori, in fact, provides a definition for the term "self-assembled film" as used in the present invention means:

a monomolecular film which is obtained by allowing a compound having a straight-chain molecule and a functional group that can be combined with the constitutive atom of a face on which the film is formed and is bonded to the straight-chain molecule to become in the state of a gas or liquid and coexistent with the face on which the film is formed. In the monomolecular film, the functional group is adsorbed by the film-forming face and is bonded with the constitutive atom of the film-forming face, and the straight-chain molecule is formed facing the outside. This monomolecular film is referred to as a self-assembled film, since it is formed by spontaneous chemical adsorption of the compound to the film-forming face.

Fujimori does not in anyway overcome the Chandler affidavit. Fujimori's "self-assembly" relates to depositing a monolayer film by **chemical adsorption**. Chemical adsorption is clearly a different pathway and not in anyway enabling or teaching to the self-assembly as presently discussed. It would almost appear to be a misnomer to describe Fujimori's chemical adsorption as self-assembly. It is not in anyway relevant to the micelle based self-assembly of **many** alternating organic/inorganic layers in a highly ordered structure as presented by Appellants.

The Examiner also states that Brinker et al do not disclose a structure that is chemically identical to nacre, or that has its moisture barrier properties. This is in clear error as Brinker states that "The present invention demonstrates an efficient self-assembly method to prepare **nanolaminated coatings that mimic the structure of shell**." Brinker C3, L 38-40. Brinker further states that even though it has hydrophobic (e.g., organic) precursors and hydrophilic (e.g., inorganic) precursors, these materials are there are PRECURSORS. The Office has not met its burden by way of any statement or discussion on how these PRECURSORS, which are present during self-assembly, function in the final structure.

CONCLUSION

For the reasons set forth above, the Appellants submit that all claims are allowable over the cited art and define an invention suitable for patent protection. The Appellants therefore respectfully request that the BPAI reconsider the application and allow the application to proceed to issuance.
Respectfully submitted,

/Hao Y. Tung/

Hao Y. Tung, Reg. No. 43,209

Date: April 6, 2012

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-18-

On Appeal to the Board of Patent Appeals and Interferences
Appellants' Reply Brief
Application Serial No. 10/698,988
Attorney's Docket No. NSL-014

VIII. CLAIMS APPENDIX

Claims on Appeal

1-11. (Canceled)

12. (Previously Amended) A device comprising:

a solar cell encapsulated with a self-assembled barrier film structure thereon comprised of:

a plurality of layers of an inorganic material; and

a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material and wherein more than one of layers of the organic polymer contain a superhydrophobic material;

wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded layers characterized by direct organic polymer to inorganic material covalent bonds which form in the self-assembled barrier film structure even with superhydrophobic material in more than one of the layers of the organic polymer;

wherein random location of pinholes in the layers of the inorganic material and the layers of the organic polymer requires a tortuous pathway marked by repeated turns or bends for any water to pass through the self-assembled barrier film structure, wherein the superhydrophobic material in more than one of the layers of the organic polymer provide surfaces that impede that movement of water between adjacent layers of the organic polymer and the inorganic material.

13. (Previously Amended) The device of claim 12 wherein the total number of layers of organic polymer and layers of inorganic material in the film is between about 100 and about 1000 layers, or between about 1000 and about 10,000 layers, or between about 10,000 layers and about 100,000 layers.

14. (Previously Amended) The device of claim 12 wherein each of the layers of inorganic material has a thickness of about 0.1 nm to about 1 nm; about 1 to about 10 nm; or about 1 nm to about 100 nm.

15. (Previously Amended) The device of claim 14 wherein the barrier film is substantially transparent.

16. (Previously Amended) The device of claim 12 wherein the barrier film has a permeability to oxygen less than about 1 cc/m²/day, 0.1 cc/m²/day, 0.01 cc/m²/day, 10⁻³ cc/m²/day, 10⁻⁴ cc/m²/day, 10⁻⁵ cc/m²/day, or 10⁻⁶ cc/m²/day.

17. (Previously Amended) The device of claim 16 wherein the barrier film has a permeability to water vapor less than about 0.01 g/m²/day, 10⁻³ g/m²/day, 10⁻⁴ g/m²/day, 10⁻⁵ g/m²/day, or 10⁻⁶ g/m²/day.

18. (Canceled).

19. (Previously Amended) The device of claim 12 wherein the superhydrophobic material includes fluororalkylsilane.

20. (Previously Amended) The device of claim 12 wherein the layers of organic polymer are made from polymer precursors to which one or more one or more hydrophobic groups have been added.

21. (Previously Amended) The device of claim 20 wherein the one or more hydrophobic groups are selected from the group of non-polar hydrophobic groups, methyl groups, benzyl (aromatic) groups, PO₄³⁻, SO₄²⁻, CH₃COO⁻, Cl⁻, Br⁻, NO⁻, ClO₄⁻, I⁻, SCN⁻ anions, NH₄⁺, Rb⁺, K⁺, Na⁺, Cs⁺, Li⁺, Mg²⁺, Ca²⁺, Ba²⁺ cations, tryptophan, isoleucine, phenylalanine, tyrosine, leucine, valine, methionine, and alanine,

22. (Previously Amended) The device of claim 12 wherein the barrier film is made from a sol including one or more Gemini surfactants.

23. (canceled).

24. (canceled)

25. (Previously Amended) The device of claim 12 wherein one or more of the layers of organic polymer and/or inorganic material are in the form of lamellae.

26. (Previously Amended) The device of claim 12 wherein one or more of the layers of organic polymer and/or inorganic material are in the form of tubules.

27. (Canceled).

28. (Previously Amended) The device of claim 12 wherein adjacent layers of the organic polymer and inorganic material are covalently bonded to each other at an interface between organic and inorganic materials.

29. (Previously Amended) The device of claim 12 wherein the layers of the organic polymer are discrete layers of organic polymer and wherein the layers of inorganic material are discrete layers of inorganic material.

30. (Previously Amended) The device of claim 12 wherein alternating layers of organic polymer and inorganic material present a long and tortuous penetration path through the barrier film to an underlying substrate.

31. (Previously Amended) The device of claim 12 wherein layers of the inorganic material are self-assembled layers of inorganic material.

32. (Previously Amended) The device of claim 12 wherein layers of the organic polymer are self-assembled layers of organic polymer.

33. (Previously Amended) The device of claim 12 wherein at least one coating of material self-assembles into the alternating plurality of layers of inorganic material and plurality of layers of organic polymer.

34. (Previously Amended) The device of claim 12 wherein layers consisting of the organic polymer and layers of the inorganic material have different material compositions.

35. (Previously Amended) The device of claim 12 wherein the layers of inorganic material are layers consisting of the inorganic material.

36. (previously amended) An inorganic/organic nanolaminate barrier film, comprising:
a self-assembled structure comprised of:
a plurality of layers of an inorganic material; and
a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material and wherein more than one of layers of the organic polymer contain a superhydrophobic material;
wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded layers characterized by direct organic polymer-inorganic material covalent bonds between adjacent layers which form in the self-assembled structure even with the superhydrophobic material in the one or more layers of the organic polymer;
wherein the layers of the organic polymer contain superhydrophobic material.

37. (Previously Amended) A device comprising:
a photovoltaic device with an inorganic/organic nanolaminate barrier film formed thereon,
wherein the self-assembled barrier film comprises:
a plurality of layers of an inorganic material; and
a plurality of layers each consisting of an organic polymer wherein the layers of organic polymer alternate with the layers of inorganic material and wherein more than one of the layers of the organic polymer contain a superhydrophobic material;
wherein adjacent layers of the organic polymer and the inorganic material are covalently bonded layers characterized by direct organic polymer-inorganic material covalent bonds between adjacent layers which form in the self-assembled barrier film even with the superhydrophobic material in the one or more layers of the organic polymer;
wherein the layers of the organic polymer contain superhydrophobic material; wherein a bottom layer of the barrier film in contact with the photovoltaic device is an inorganic layer;
wherein random location of pinholes in the layers of the inorganic material and the layers of the organic polymer requires a tortuous pathway marked by repeated turns or bends for any water to pass through the self-assembled barrier film structure, wherein the superhydrophobic material in more than one of the layers of the organic polymer provide surfaces that impede that movement of water between adjacent layers of the organic polymer and the inorganic material.

38. (previously amended) The barrier film of claim 12 wherein superhydrophobic decreases the permeability of the barrier film while still providing for self-assembly of nanostructures by way of micelle formation and incorporation of polymer precursors into the micellar interiors and the barrier film is at least 1000 nm thick comprised of individual layers, each about 1 nm thick.

IX. EVIDENCE APPENDIX

The Chandler Affidavit of June 11, 2009 is relied upon in this appeal brief.

X. RELATED PROCEEDINGS APPENDIX

None- no decision rendered by a Court or the Board in any related proceedings identified above.